Pacific Island Network
Vital Signs Monitoring Plan

Appendix A: Kaloko-Honokohau National Historical Park Resource Overview

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Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands
American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii
USS Arizona Memorial, Oahu (USAR)
Kalaupapa National Historical Park, Molokai (KALA)
Haleakala National Park, Maui (HALE)
Ala Kahakai National Historic Trail, Hawaii (ALKA)
Puukohola Heiau National Historic Site, Hawaii (PUHE)
Kaloko-Honokohau National Historical Park, Hawaii (KAHO)
Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)
Hawaii Volcanoes National Park, Hawaii (HAVO)

http://science.nature.nps.gov/im/units/pacn/monitoring/plan/

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EXECUTIVE SUMMARY AND INTRODUCTION

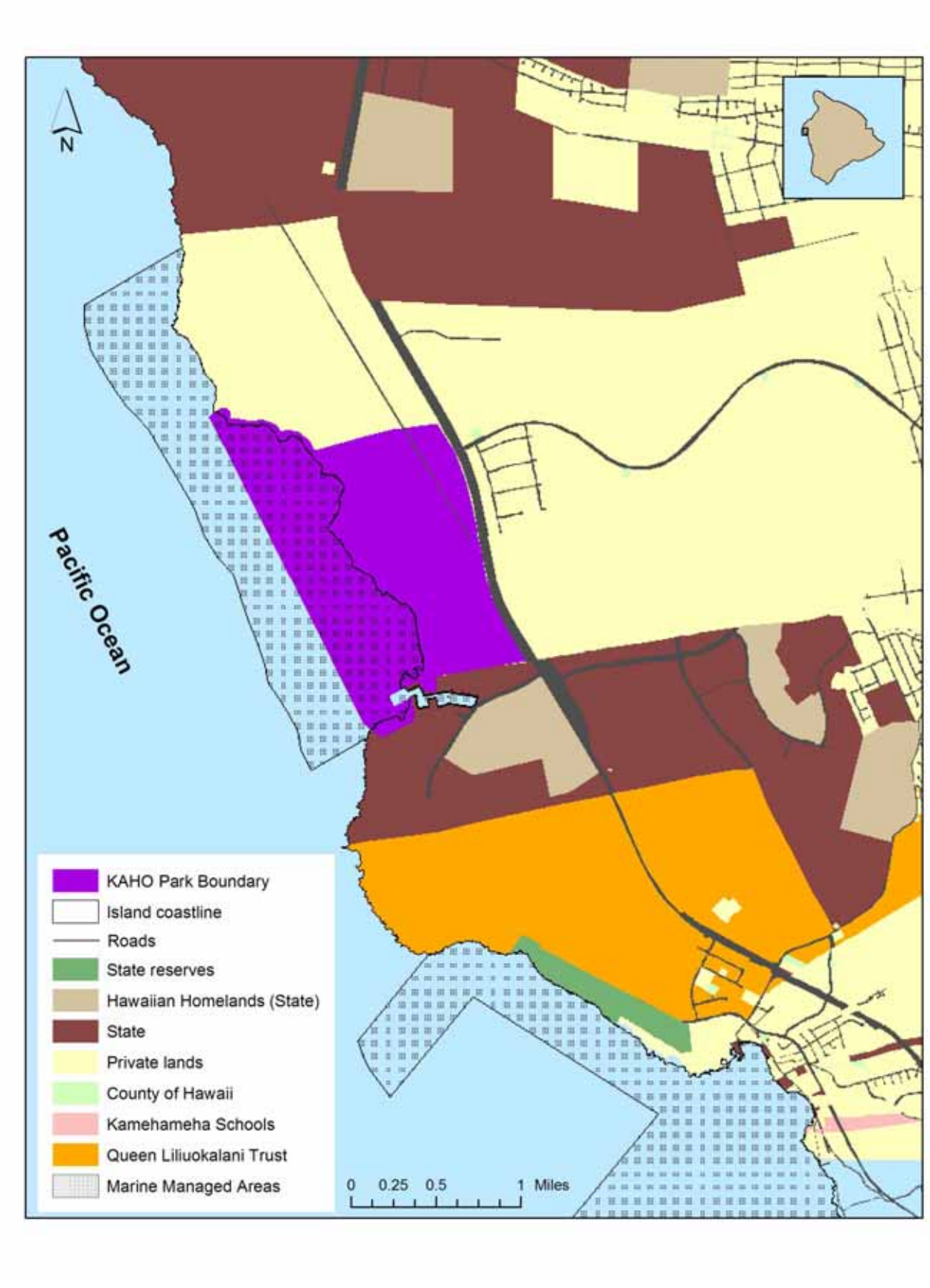
Enabling Legislation

Kaloko-Honokohau National Historical Park (KAHO) was established on November 10, 1978: "In order to provide a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture, and to demonstrate historic land use patterns, as well as to provide a needed resource for the education, enjoyment, and appreciation of such traditional native Hawaiian activities and culture by local residents and visitors." This act authorized the purchase of privately-held lands within it's boundary with donated or appropriated funds. Submerged lands are managed through a cooperative agreement with the State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources (DAR). Fishing and shoreline gathering are permitted when consistent with park mandates. The park will enter into air and water quality agreements with surrounding landowners utilizing the ahupuaa concept of land management. An Advisory Commission was established for a ten year period to counsel managers on aspects of Hawaiian culture demonstrated within the park.

To find enabling legislation documents on-line follow the "Policy & Legislation" link from the Pacific Island Network website (www1.nature.nps.gov/im/units/pacn).

Geographic Setting

KAHO is located three miles north of the town of Kailua-Kona on the western shoreline of the Island of Hawaii. The islands population is approximately 150,000. KAHO is 1,160 acres in size, including 596 acres of marine waters along the Western shoreline (see map below), as well as two large fishponds, a fishtrap, and several dozen anchialine pool and wetland complexes. The Island of Hawaii is the largest and youngest of the Hawaiian Islands with three active and two dormant volcanoes. KAHO is located on a combination of flat basalt and rough volcanic deposits from the volcano Hualalai that last erupted in 1801. Honokohau Harbor and its associated fuel and maintenance facilities border the park to the south. A county wastewater treatment plant discharges treated effluent within a mile upslope of the harbor and KAHO boundaries. This area also contains a county landfill that accepts cars and appliances. The lands to the north of the park will be developed as a resort consisting of a golf course and multi-family housing units. Just across the Eastern boundary, marked by Queen Kaahumanu Highway, lies a rock quarry, equipment storage areas, a gasoline station, and a business district that is under steady expansion. In 2002, the area around the quarry was rezoned from "conservation" to "urban", adding 104 acres to the light industrial development upslope of the park.


N
Pacific Ocean
KAHO Park Boundary
Island coastline
Roads
State reserves
Hawaiian Homelands (State)
State
Private lands
County of Hawaii
Kamehameha Schools
Queen Liliuokalani Trust
Marine Managed Areas
0 0.25 0.5 1 Miles

Significant Natural and Cultural Resources

Natural resources in this park include coral reefs, both sandy and rocky shorelines, anchialine pools, wetlands, dryland forest, and bare lava fields. Endangered and threatened species and species of concern within the park include: the Hawaiian stilt (*Himantopus mexicanus knudseni*) and Hawaiian coot (*Fulica americana alai*), the hawksbill (*Eretmochelys imbricata*) and green sea turtles (*Chelonia mydas*), the Hawaiian monk seal (*Monachus schauinslandi*), migrating humpback whales (*Megaptera novaeangliae*), an anchialine snail (*Neritilia hawaiiensis*), a native damselfly (*Megalagrion xanthomelas*), a plant (*Bidens micrantha*), and several species of anchialine shrimp including *Palaemonella burnsi*.

Ancient burial sites, petroglyphs, salt pans, and the rocks themselves are important cultural resources at KAHO. There are two ancient man-made fishponds and a fishtrap that were managed to provide a consistent food supply. Numerous anchialine pools supplied water for human use, and later, for domesticated livestock. The productive marine areas offshore of KAHO together with the fishponds were the most significant resources to historical and ancient residents (Peterson and Orr 2004).

Resource Management Priorities

Protection of the threatened, endangered, and rare species, the control of alien organisms, and water quality are central to natural resource management at KAHO. The park's general management plan highlights preservation, restoration, and interpretation of traditional Hawaiian culture and values, and includes maintaining traditional access to fishing and gathering areas. The restoration of native plant communities is ongoing in several locations within the park. Plans are in progress for Kaloko fishpond to accommodate traditional Hawaiian aquaculture following restoration of the wall and removal of invasive algae.

NATURAL RESOURCES

Focal Ecosystems and Processes

- Marine ecosystems including coral reefs
- Anchialine pools, which support endemic species, are nationally unique
- Aimakapa and Kaloko fishponds and associated wetlands and waterbirds
- Aiopio fishtrap
- Native plants and animals, including threatened, endangered, and candidate species

Most of the focal natural resources in KAHO are located along the coastline. The coral reefs located in KAHO are an important resource because the island is geologically young and reefs, especially in Kona, are typically less extensive than elsewhere in the state. This park is one of three National Park units in Hawaii to include marine habitat. Significant coral growth is located in the waters adjacent to parklands, in Honokohau Bay, Alula Bay and offshore of Kaloko Pond.

Anchialine pools are a significant resource due to the rarity of this habitat type, and are threatened by coastal development statewide. Anchialine pools are isolated brackish water pools with subterranean connections to the sea. KAHO is one of only three natural reserve sites with anchialine pools in the state of Hawaii and contains approximately 10%

of the anchialine pools on Hawaii Island. Relative to this habitat type worldwide, anchialine pools in Hawaii are species-rich and have a high degree of endemism. Anchialine pool organisms live in areas with access to light, in subterranean waters, or migrate between these environments.

Two brackish ancient Hawaiian man-made fishponds, Aimakapa and Kaloko, and their associated wetlands provide habitat to aquatic species. Aimakapa Fishpond is fresher than Kaloko Fishpond and provides habitat for nesting waterbirds and migratory shorebirds.

The most critical vegetation resources at KAHO consist of wetland communities, coastal strands, and plants associated with anchialine pools. Native terrestrial plant diversity is limited due to historic and current land use practices. KAHO does contain native and Polynesian introduced flowering plant species such as milo (*Thespesia polpunea*), ilima (*Sida fallax*), and naupaka (*Scaevola sericea*). There is a large population of pua pilo (C*apparis sandwichiana*), which is a species of concern, and smaller numbers of other rare plant species, such as naio (*Myoporum sandwicense*) and aalii (*Dodonaea viscosa*). In addition, there is one candidate endangered plant, kookoolau (*Bidens micrantha*), known to exist in this park.

Threatened and Endangered Species: The endangered hawksbill turtle and the threatened green sea turtle inhabit the park's marine waters. Kaloko-Honokohau and the Kona coast are one of the only areas in the state where green sea turtles do not suffer from fibropapilloma tumors. The endangered humpback whale and the endangered Hawaiian monk seal have also been observed within the park. Researchers determined that these seals were born on Hawaii Island (one just a few miles north of the park), and could contribute to a desired increase in the local population. Anchialine pools at KAHO are a primary breeding site for the orangeblack Hawaiian damselfly (*Megalagrion xanthomelas)*, a candidate for endangered status. The candidate endangered shrimp *Metabetaeus lohena* and species of concern *Halocaridina rubra* are found in anchialine pools at KAHO. Other rare species may be found, including candidate endangered species *Palaemonella burnsi*, with more intensive surveys. The rare anchialine snail species *Neritilia hawaiiensis* has also been reported from the park. Aimakapa Fishpond and its related wetland provide critical habitat to two species of endangered waterbird, the Hawaiian coot (*Fulica alai*) and Hawaiian stilt (*Himantopus mexicanus knudseni*), as well as several other resident or migrant waterbird species. The endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) has been observed flying offshore, but is not known to nest or roost in the park.

Threats & Stressors

- Invasive plants and algae impact native species survival.
- Proximity of development affects water quality and aquatic ecosystems.
- Harbor expansion brings increased risks from boating, pollution, and potential introduction of alien species.
- Fishing pressure, including use of monofilament gill nets impact marine fauna.
- Groundwater depletion & contamination affect aquatic communities.
- Alien predators impact native organisms.
- Air quality deterioration affects reef organisms, viewscapes, and animal health.
- Sea level rise threatens coastal resources.

- Visitor use brings impacts to shorelines, reefs, and harvest organisms.

Although remnants of the coastal strand persist with significant wetland communities, the vegetation of most of the park has been altered by invasive plant species. These invasives include red mangrove (*Rhizophora mangle*), pickleweed (*Batis maritima*), koa haole *(Leucaena glauca*), christmasberry (*Schinus terebinthifolius*), ivy gourd (*Coccinia grandis*), and alien grasses. Important invasive plants are kiawe (*Prosopis pallida*) in shoreline areas and fountain grass (*Pennisetum setaceum*) on previously bare lava flows. Fountaingrass is fire tolerant while associated native plants are not. Brush fires in this environment effectively remove native plants and foster the spread of this invasive bunch grass. The main stressors on vegetation are development of coastal lands near the park, alien plant species, erosion of sandy shoreline, invasive alien ungulates, rats, ants, loss of biodiversity, and visitor impacts to natural resources. The high percentage of exotic plant species is reflected in the dominance of introduced insects. Some native insects may still be found in the park, especially species with aquatic larval stages that are less affected by ants.

The small boat harbor (Honokohau Harbor), adjacent to the park boundary, is State operated and slated for expansion in the near future. This expansion will increase impacts to marine resources from harbor construction activities and increased boating due to commercial diving and fishing charters. Current or potential threats from the proximity of this facility include impacts of underwater noise pollution on marine organisms, increased boat strikes to turtles, introduction of alien algae and invertebrates, viewscape impacts, boat groundings, and other physical damage to reef resources. Boat maintenance activities and illegal dumping contribute to contamination of marine resources by lead paints, paint base, diesel, oils, heavy metals and sewage. Currently, there is no sewage pumping station at the harbor. Added fishing pressure, including gill netting and scuba spearfishing, also impact the marine community. Of particular concern is increased risk of entanglement of turtles in discarded tackle. In addition, collections for the aquarium trade are banned in park waters by state law but enforcement is lacking. Various types of fishing (pole, net, spear) still occur within the park and are conducted primarily from the shoreline. There is no data available to assess the catch rates or fishing pressure.

Threats to freshwater resources include the presence of alien fishes (primarily guppies and minnows) in anchialine pools, encroaching alien vegetation, shrimp collection, and sea level change. These pools may be negatively impacted by human use, litter, dog feces, encroachment by vegetation, and alien organisms such as fish or predatory invertebrates. Filling of ponds with sediment and alien plant matter contribute to the loss of riparian habitat for endemic invertebrates and semi-aquatic insects. The pumping of groundwater for residential, commercial, and golf course irrigation, and the subsequent reduction in flow, may be affecting species dependent on this freshwater source.

In addition, groundwater quality and quantity are impacted by the presence of an expanding light industrial area directly upslope from the park, a wastewater treatment facility and Honokohau Harbor to the south, and a planned resort/golf course development adjacent to the north side of the park. Development of golf courses has also been proposed upslope of park boundaries, with potential associated problems of groundwater depletion and nutrient enrichment.

Potential outbreaks of avian botulism and predation by feral cats and mongooses pose significant threats to waterbird species. An outbreak of avian botulism in 1994 resulted in increased mortality of the endangered native waterbirds, Hawaiian coots and Hawaiian stilts, and could reoccur under the right combination of conditions; such as lowered pH, elevated temperature, and an anaerobic, nutrient-rich environment (Morin 1994). Proximity of the harbor dumpsters and feeding by a local animal welfare group provide feral cats and mongooses with a supplemental food source. Feral dogs are also an occasional problem. Pet dogs are allowed in the park and, though they are required to be leashed, often are not. Unleashed dogs pose a threat to basking sea turtles and nesting waterbirds. Other stressors to terrestrial resources include feral herbivores such as goats, invasive plant species, and invasive insect species. Plants suffering from rodent seed predation likely include the naio (*Myoporum sandwicense*), pua pilo (*Capparis sandwichiana*, a species of concern), and the endangered loulu palm (*Pritchardia affinis*).

The air quality in the park is impacted by a quarry that releases known but unquantified particulates upwind from the park. Vog (volcanic smog), which also impacts air quality, results from eruptions of Kilauea. Other general stressors include loss of coastal resources due to sea level rise, subsidence, and periodic high surf events. Global climate change and associated severe weather events could change sea surface temperatures, impacting food supply for marine birds, and causing physical changes to coastal resources. Severe weather events such as storms and floods, particularly during the breeding season, can impact ground and open-cup nesting birds and their habitat.

The park's new visitor contact station helps visitors enjoy the park. This development is located at a former quarry site in order to minimize impacts to undisturbed sections of the park. The visitor center will feature examples of native plants and agricultural techniques. Infrastructure for the center includes a parking area (75 stalls) for buses and cars, adjacent to the visitor center, and necessary utilities (telephone, electric and sewer).

Water Quality Designations

In Hawaii, water bodies are classified by their designated use according to the Hawaii Revised Statutes, Section 11, Chapter 54, which contains definitions and water quality standards for each water body type with respect to desired uses. Waters that do not meet the criteria for their designated uses are considered non-supportive and, if certain conditions are met, may be reported as impaired to the Environmental Protection Agency as per requirements of the Clean Water Act, Section 303(d). At KAHO, there is very limited water quality information to provide a basis for listing, and no water bodies are listed as impaired. Although Hawaii does not have a designation category for outstanding natural resource waters, managers have identified the wetlands, anchialine pools, and coastal waters of KAHO as unique or pristine resources worthy of special attention. These inland surface waters are classified as 1a; prohibiting pollution by humans and requiring maintenance of their natural wilderness character. This same protection is extended to the park's marine waters classed as AA and marine bottom ecosystems category II. Marine waters and benthic ecosystems within Honokohau Harbor are classified as A and I respectively in order to allow for impacts relating to harbor operations. Groundwater designations are being developed by the state of Hawaii, but are not available at this time.

CULTURAL ISSUES

- Landscape management to restore native plants
- Restoration of Kaloko Fishpond wall
- Fishpond management for food production
- Harvest of plants and animals for traditional uses

Due to the ancient Hawaiian history of the land, use of natural resources, and abundant archeological evidence, KAHO is considered a sacred place with many culturally significant resources. It is important to continue identifying these culturally significant resources in an effort to preserve the historical features and interpret their relationship to the associated natural resources. In the interest of restoring the traditional landscape, the dryland habitat is being replanted in selected areas through a cooperative agreement between the park and Tropical Reforestation & Ecosystems Education Center (TREE Center).

In ancient times, marine resources located at KAHO were crucial to Hawaiian subsistence as evidenced by location of the two fishponds and the fishtrap. The seawall of Kaloko Fishpond is under repair and the park plans to restore the pond habitat for traditional aquaculture purposes. This pond restoration will include control of an alien marine algal species and stocking the pond with traditionally used native fishes. Protection of water quality and quantity of supply to the fishpond is crucial to the successful restoration of this pond.

Anchialine pools are also important culturally. They were a significant water source for drinking water and were used by native Hawaiians for food, bathing, and ceremonial purposes. Traditional gathering rights include access to rare species (shrimp), which may be impacted by such activities, as well as changes to the surrounding landscape and groundwater supply.

MANAGEMENT ISSUES

Park Management

Park management is tasked with the preservation and interpretation of park resources to visitors as well as providing access to native Hawaiians for traditional cultural practices. Conservation of the park's natural resources is an intrinsic part of maintaining Hawaiian cultural traditions, which entail gathering plants, animals, and rocks from the land and sea for use as food, tools, shelter, and trade. Managers are in the process of restoring the native vegetation and historical landscape in targeted areas, which include the wetlands surrounding the fishponds and, most notably, the restoration of the Kaloko fishpond wall. The marine areas are studied through monitoring projects and managers are proactive in neighboring land management activities when possible.

Park management documents (General Management Plan, Resource Management Plan, etc.) are available on-line at the NPS intranet site (www1.nrintra.nps.gov/im/units/pacn/parks/mgmt_docs.htm). This website is currently available only from NPS computer networks. Inquiries about public access should be directed to the park.

A primary management concern is the ongoing development of lands surrounding the park that were zoned for conservation purposes at the time of the park's founding. These lands have since been rezoned as "Urban" by the Hawaii Land Use Commission and have current or planned industrial development. The expansion of Honokohau Harbor will require good planning to minimize the variety of potential impacts to the park's marine resources. Land use upslope from the park is likely affecting both marine and groundwater quality in the park due to untreated stormwater runoff and the lack of a sewer system. Escalating withdrawal of groundwater may lead to a drop in the available freshwater supply, and increased salinity, producing potentially significant changes in the anchialine pool habitat. Research is needed to understand groundwater dynamics of the area and to quantify the impacts of land use on water resources.

Several threatened and endangered species, as well as candidate endangered species, are found within the park. A myriad of issues are included in maintenance of habitat for these species, including water quality, human consumptive use, control of predators and invasive plants, as well as visitor impacts. Increased human use may disturb shorebirds, basking and nesting turtles, and basking monk seals within the park. Development surrounding the park brings changes in viewscapes, soundscapes, and ambient light at night. The Federal Aviation Administration in cooperation with the National Park Service has initiated the development of an Air Tour Management Plan to mitigate or prevent the significant adverse impacts of commercial air tour operations upon natural resources, cultural resources, and visitor experiences at national park units.

Invasive plant control is underway in both wetland and dryland areas of the park. Native plants are being restored in tandem with alien plant removal. Wetlands surrounding the two large fishponds are significant examples of much depleted plant communities. For example, the *Bidens* population has declined to a few individuals, therefore this species requires re-introduction rather than monitoring. Currently, no alien plant monitoring is occurring other than informal evaluation of treatment effectiveness. Treatment involves clearing of fountain grass and assorted alien shrubs from sites near Kaloko Pond, trails within the park, and in seven acres along the new interpretive trail to Honokohau Beach. The long-term plan is to clear the south 86 acres of the park and restore appropriate native plants and Polynesian introductions to this area. Clearing of invasive plants has fulfilled park goals of fire management, visitor safety, ecosystem restoration, and protection of cultural resources. The General Management Plan (1994) proposed eventual clearing of most alien vegetation and its replacement with native or culturally important plant species. Plans also include the removal of an invasive marine algal species found within Kaloko Fishpond.

Restoration of native plant communities is essential to the conservation of native invertebrates such as a rare coastal population of native bees (*Hylaeus sp.*) that rely on the coastal strand. Several specialized endemic insects are dependent on the species of concern (SOC) plant *C. sandwichiana* as a host, and should be monitored. Management is also concerned that many of the anchialine pools have been invaded by alien mosquito fish, resulting in the extirpation of native arthropods.

Predators such as mongooses, feral cats, and occasionally dogs harass and prey upon waterbirds. The proximity of the state small boat harbor's dumpsters to the park boundary may also play a role in maintaining predator populations. A local group concerned with

the welfare of feral cats provides food near the park boundary, further maintaining and enhancing the invasive predator populations. The park is trapping mongooses on a seasonal basis and is experimenting with the use of diphacenone as a predator control agent.

INVENTORIES

Existing Inventories in Park

Vegetation: KAHO vegetation was mapped in 1987 by using aerial photographs from 1959 and 1982 (Canfield 1990), and was later surveyed by Pratt and Abbott (1996) who reported that 116 vascular plant species were found within Kaloko-Honokohau in 1992-93. Eighty (69%) plant species were alien, four (3%) were Polynesian introductions, 27 (23%) were indigenous, and five (4%) were endemic. .Fifty-six species (46 aliens, 9 indigenous, and 1 endemic) were additions to the known flora of the Park since the previous plant checklist (Canfield 1990).

In August of 2001, Randy Nagle of NPS completed a census of six rare plant species in a 35-ha (86-acre) parcel in the southern part of the park. The park records all native replantings by the TREE Center. Some pollen analysis has been done for Aimakapa Pond (Pratt 1998) and further pollen core research is planned to identify native plants formerly growing in or near the park.

Terrestrial Vertebrates: Morin (1996) documented 25 bird species out of 86 listed for KAHO including two endangered waterbirds. Notes on shorebird species occurring in the park have been kept by park staff and the Hawaiian hoary bat has been observed in KAHO as well.

Terrestrial Invertebrates: A survey of the insect fauna in 1992 (unpublished) found relatively few native terrestrial arthropods aside from flies breeding in the pools. Sporadic insect collections have been made since then. In 1987 a cerambycid-like beetle was collected from a coconut log in Kaloko fishpond and identified as *Sessinia levida* (f.); an island and state record at the time (Davis, 1988).

Freshwater Communities: Chai (1991***),*** Brock and Kam (1997) and Brasher (1999***)*** surveyed the anchialine pools Currently, USGS-BRD is inventorying selected invertebrates and water chemistry in some anchialine pools for the I&M program.

Marine Communities: Brock and Kam (1997) inventoried fish and invertebrates in Kaloko Fishpond. Research on spinner dolphins (*Stenella longirostris*) was conducted in 1989 by Jan Ostman (http://www.kulanaia.org/research2.html) which included research on the behavior, movement, and population dynamics of the park's "resident" pod. Recent data on fish in and near park waters are available from Hawaii Division of Aquatic Resources. Parrish et al. (1990) documented 150 marine fish species within the Park boundaries.

The International Archaeological Research Institute conducted an ethonographic study of marine resource utilization by native Hawaiians to better understand natural resources and cultural values of the park.

Invasive Species: In 1992-94, weed frequency and estimated cover-abundance data were collected from belt transects (Pratt 1998). These baseline data will be useful in a monitoring program to determine trends in alien plant cover. A vascular plant checklist developed during the 1992-94 project was revised several years later. Comparisons with a 1988 checklist (Canfield 1990) indicated that alien plant species continue to appear in KAHO as invaders from nearby areas, particularly along roads, trails, and in disturbed areas.

Rats and mice were recorded in the park in the 1990s (Stone et al. 2002). Alien mammals observed at KAHO by park staff and researchers consist of rabbits, mongooses, rats, goats, feral cats and feral dogs.

During the late summer of 2004, a herpetological inventory was performed at KAHO, PUHO, and PUHE by Bazzano (2005). Each park had a morning and night survey in areas most likely to contain reptiles. Five species of gecko and one skink were found. There are no aliens of concern documented in West Hawaii parks yet. At KAHO, the Jackson chameleon and coqui frog have been reported from locations close to the park. The snake-eyed skink (*Cryptobleupharus peopcilopleurus*) was seen only at KAHO of the three West Hawaii parks, near the anchialine pools. Only one house gecko, (*Hemidactylus frenatus*), which were dominant at PUHE, was observed at KAHO. One tree gecko (*Hemiphyllodactylus typus*) was observed. The gold dust day gecko (*Phelsuma laticauda*) appeared to be rapidly increasing in population at both KAHO and PUHO. The stump-toed gecko (*Gehydra mutilate*) and mourning gecko (*Lepidodactylus lugubris*) are less aggressive and were found in lower numbers.

Geology: NRCS (Natural Resources Conservation Service) has soil maps of all Hawaiian islands based on research conducted in the 1950s and 1960s (Cline et. al. 1955, Foote et. al. 1972).

Landscape: Some preliminary sound testing was conducted at KAHO in May of 2003 by the Natural Sound Program. This information will be primarily used to assess the natural soundscape for the upcoming Air Tour Management Plan.

Priorities for New Inventories in Park

Vegetation: Vegetation sampling before and after alien plant clearing would allow evaluation of treatment effectiveness, and for development of efficient re-treatment schemes.

Terrestrial Vertebrates: No inventories of mammal species have been done for KAHO, and no vouchers of mammals for the park have been located (Hu et al. 2000).

Terrestrial Invertebrates: The park needs a more specific search for native insects associated with native plants.

Freshwater Communities: Night surveys are needed to inventory hypogeal shrimp species in anchialine pools. Aimakapa fishpond has not been inventoried for fish species.

Marine Communities: Inventory work is needed and planned for corals, other invertebrates, algae and to a lesser extent, fish. An inventory of cartilaginous fish occurring in the park is also needed.

Invasive Species: It would be worthwhile to document the appearance of newly invasive alien plants and the relative cover of native and alien plants at some sites of high natural value.

Buffer Zone Inventories

Terrestrial Invertebrates: Mammal and bird surveys were part of preparations for a petition to the Hawaii Land Use Commision in 1986 for rezoning of the Kohanaiki shoreline (Rutter/KW Kohanaiki 2003).

Terrestrial Invertebrates: Native bees have been found in Kohanaiki to the north of KAHO (Polhemus 1996).

Freshwater Communities: USGS has documented the locations of anchialine pools north and south of KAHO fishponds, inside and outside of KAHO boundaries. A preliminary inventory of anchialine resources was also a part of preparations for development of the Kohanaiki shoreline (Rutter/KW Kohanaiki 2003).

Invasive Species: No reptilian aliens of concern are documented in West Hawaii parks. At KAHO, the Jackson chameleon and coqui frog have been reported from locations close to the park (Bazzano, 2005).

Air quality: There is a need for more information about particle deposition from the quarry and vog impacts.

MONITORING

Existing Monitoring in Park

Vegetation: Monitoring alien plant species consists of treatment effectiveness records. Reintroduced native plants are recorded using GPS and are monitored for success/failure rates. There are data on transect frequency and density for pua pilo (*C. sandwichiana*) which should be repeated to monitor the status of this SOC within the park.

Recent outplanting of kookoolau will be monitored for survival. One of the species of concern (the sedge *Fimbristylis hawaiiensis*) was monitored in fountain grass removal plots for two years (Pratt unpublished data). There are data on transect frequency and density for pua pilo that could be repeated to monitor the status of this SOC within the park (Pratt and Abbott 1996a). Recently, staff and cooperators inventoried six rare plant species in an 35-ha (86-acre) parcel in the southern part of the park; these rare plants included the candidate endangered kookoolau, the species of concern pua pilo, and depleted common species iliee (*Plumbago zeylanica*), alahe`e (*Psydrax odorata*), and aalii

Terrestrial Vertebrates: Wetland bird populations are monitored at Aimakapa Pond through an agreement with Ducks Unlimited.

Terrestrial Invertebrates: Populations of a native damselfly (*Megalagrion xanthomelas)* breeding in the pools have been monitored for several years, but surveys for other important species have been sporadic.

Marine Communities: The park has conducted cooperative green sea turtle monitoring with the Pacific Islands Fisheries Science Center (NOAA/NMFS) Marine Turtle Research Program and the Hawaii Preparatory Academy since 1999. Summary data sheets are available at the park. The University of Hawaii at Hilo has recently began sea turtle forage studies and anchialine pool studies. Research on the recruitment processes of key coral reef invertebrates and fishes (mainly aquarium species) by NPS and USGS Pacific Science Center collaborators began in 2003.

Invasive Species: Effectiveness of resource management is monitored by recording the number of animals trapped in the predator management effort, as well as results of alien plant eradication efforts.

Water Quality: A two-year project funded by NPS Water Resources Division to monitor nutrient fluctuations in wells, anchialine pools, Kaloko Fishpond and Aimakapa Fishpond is underway by UH Manoa. This project will perform dye tracer studies to determine the residence time of water in the pools and ponds and will collect samples to analyze for biologically available nitrogen and phosphorus in the groundwater. Salinity, dissolved oxygen, silica, chlorophyll a and other pigments will also be monitored.

Climate: The only weather parameter being measured for years was precipitation. A RAWS weather station was installed in March 2005 and current data is available online at

http://raws.wrh.noaa.gov/cgi-bin/roman/raws_ca_monitor.cgi?state=HI&rawsflag=2

Priorities for New Monitoring in Park

Terrestrial Invertebrates: Native bees and damselflies are in need of monitoring in this park.

Freshwater Communities: Monitoring of aquatic flora and fauna is lacking at KAHO.

Marine Communities: Planned monitoring includes coral reef health (composition, fish numbers, and marine water quality), and the marine soundscape, focusing on low frequency anthropogenic sounds in the park waters (The Kula Naia monitoring project).

Water Quality: Groundwater quantity and quality are of primary concern as development around the park increases.

Climate: An automated weather station will be installed in the near future (March 2005). Impacts to air quality from the adjacent quarry need to be addressed.

Invasive Species: UH Manoa, PCSU, KAHO staff, and community groups will be investigating and removing invasive algae from Kaloko Pond and monitoring for changes in benthic biota and substrate as well as monitoring the reef in front of the pond.

Buffer Zone Monitoring

Terrestrial Vertebrates: Ducks Unlimited has been monitoring the Hawaiian Stilts that have colonized a man-made wetland 4 miles to the north of KAHO at Keahole Point for the last three years.

Marine Communities: The West Hawaii Aquarium Project, a multi-agency project, (http://coralreefnetwork.com/kona/) has been studying aquarium fish in 23 sites along the West Hawaii coast since 1998. They are researching the effects of aquarium fish

collecting by comparing results from Marine Protected Areas and Fish Replenishment Areas with those open to collection. Data collected include fish densities, recruitment patterns, coral cover, abundance, diversity, distribution, and the complexity of the three dimensional habitat (rugosity).

***Water Quality*:** The Hawaii State Department of Health monitors public swimming areas for human health parameters at Kailua Pier, three miles to the South of KAHO. The Natural Energy Laboratory of Hawaii has been performing a Comprehensive Environmental Monitoring Program since the early 1980s that includes nearshore transects, surface and abyssal seawater, anchialine pools and groundwater. Indicator levels are high at Kailua Pier, suggesting some risks to human bathers.

Geology: The Tsunami Warning System continuously monitors the seismic activity and ocean surface level of the Pacific Basin

***Climate*:** Complete weather monitoring is conducted by NOAA-NWS at the Kona International Airport three miles to the North.

CONCLUSION

Designated as a historical park, management priorities at KAHO include the maintenance of cultural activities and preservation of cultural and natural resources such as the restoration of Kaloko fishpond for traditional Hawaiian aquaculture. In the future, management efforts will continue to be directed towards the control and/or removal of invasive plants and predators, and towards groundwater monitoring for impacts to the anchialine pools, fishponds, and nearshore resources. These issues are central to NPS goals for the protection and management of native, threatened, and endangered species. The turtle monitoring program is well under way, and so is the reintroduction of native plants, including threatened, endangered, and species of concern.

Natural resources at KAHO include coral reefs, sandy and rocky beaches, fishponds, wetlands and anchialine pools, grassland, lava fields, and coastal dryland forest. Primary threats to resources include increasing urbanization, invasive species, non-point source pollution, terrestrial and marine recreational damage, marine and groundwater contamination, groundwater withdrawal, sea level rise, subsidence, high fishing pressure, and marine debris. As this natural oasis becomes surrounded by urbanization, managers will continue to try to influence development plans to minimize their impacts to these globally and locally unique treasures. Biodiversity in the islands is diminishing rapidly and the value of natural populations is immeasurable. Conservation and restoration of the natural resources at KAHO can help to sustain both environmental and cultural resources for generations to come.

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